# Brantford "IDEAL" Gas and Gasoline Engines

## INSTRUCTION BOOK

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BRANTFORD, CANADA

# Prefatory Note

IN the introduction of the "IDEAL" Gas and Gasoline Engines we have taken every advantage to simplify them in such a manner that it would not require an expert to operate them; but we would, nevertheless, advise customers to carefully study the contents of this booklet, also to make themselves thoroughly familiar with the engine before starting, as it is important to thoroughly understand the engine, as well as the instructions.

Do not tinker with the engine, as they are perfect when they leave the factory, and should start without making any changes whatever.

The economy, reliability and durability of engines depend largely on the operator's knowledge of his engine, and we have endeavored in this Booklet to fully explain all the parts of the "IDEAL" Engines, and to set before the reader the fundamental principles that control Gas and Gasoline Engines. We would therefore advise you to lay away this booklet in a safe place for future reference.

## LOCATION OF ENGINE ROOM.

The engine which is practically the head of the machinery plant, should be installed in a light, dry place, easy of access by the attendant. Sufficient space should be allowed all around the engine to make all parts of it easily accessible.

If it is necessary to install it in a basement or cellar, partition that part off, so that the engine may be kept clean and dry.

Place the engine, if possible, with the drive pulley on the exhaust side, as this position gives the operator free access to the working parts, and affords better facilities for starting, oiling, etc.

Our pulleys will fit either side of the engine, and you may observe from the plan, Figure 1, Page 3, just what the position of the driving pulley will be, in reference to the foundation. It is always practical, if your line shaft is in position, to make an allowance of at least an inch either way on the shaft, for the adjustment of the driven pulley.

When the engine is installed on an upper floor, place it as near the wall as possible. It is a good idea to fill in between the joists with concrete, and if near the wall, anchor the concrete and the wall together. A small engine, however, may be bolted to a pair of heavy timbers or skids and then fastened to the floor.

## FOUNDATION.

The foundation should be made of concrete, brick, or stone, laid in good quality of cement mortar.

A good concrete foundation is made up of the following proportions:—One part cement, two parts sand, and five parts finely cracked stone or gravel.

While building the foundation in freezing weather, protect it from the frost as much as possible, since frozen cement or mortar is of little use.

In deciding the dimensions of the foundation it is a good rule to make the length at the bottom of the foundation twice the length of the engine base, and the width at the bottom from two to two and a half times the base; then bring it up to a batter or incline to the floor line or level of the ground.

However, a foundation may be made almost any shape, this depending to a certain extent on the situation, grade of soil, and other local conditions.

## ANCHOR BOLTS.

In setting or placing the anchor bolts in position, it is considered a good practice to make a templete the same size as the engine base (See Figure 1). Bore holes through the templete to correspond with holes in engine base—see that holes are perfectly square with each other. Place the templete in position with bolts hanging down and extending above the wood enough to allow for the thickness of the metal at the holes in the base. The bolts may also be placed in casings or pieces of pipe about ½" larger inside than the bolts, to allow for any slight deviation in the distance between them. The casings, however, should not extend in height above the foundation.

The top of the foundation should be finished by a dressing of cement, and made perfectly flat and level. The engine should not be placed until this is thoroughly set.

While the engine is being bolted to the foundation, be careful not to strain the bed by tightening the nuts unevenly. Each nut should be drawn down a little at a time, tightening each in turn until all are down and drawing evenly on the bed.

The Cut (Figure 1, Page 3) represents the plan and sizes in the foundation of all sizes of the Ideal Engine up to 19 H.P.

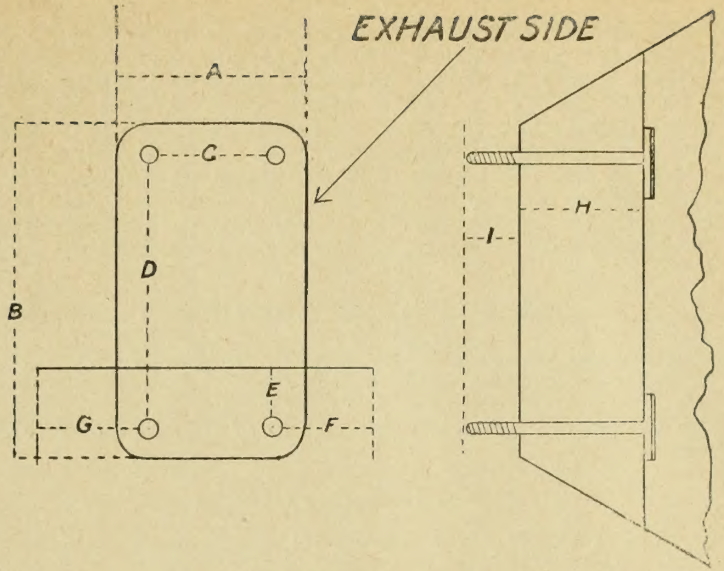



**FIG. 1.**

| | H. P. 2-3 | H. P. 4-6 | H. P. 7-8 | H. P. 11-13 | H. P. 14-16 | H. P. 17-19 |
|---|---|---|---|---|---|---|
| Width of Base of Engine .....A | 14 | 18 | 21 | 23 | 25 | 29 |
| Length of Base of Engine .....B | 36 | 48 | 57 | 64 | 72 | 77 |
| Distance between Holes crossways .....C | 9 ¼ | 13 | 14 ¾ | 16 ½ | 18 ½ | 22 |
| Distance between Holes lengthwise .....D | 28 ¾ | 39 ¼ | 46 ¾ | 50 ¼ | 60 ¾ | 64 |
| Distance from two front holes to crankshaft .....E | 5 ½ | 7 ½ | 9 ½ | 9 ½ | 12 | 11 ½ |
| Distance from hole to inside face of pulley exhaust side F | 5 ½ | 4 ½ | 4 ½ | 6 ½ | 6 ½ | 5 ½ |
| Distance from hole to inside face of governor side....G | 6 ¼ | 7 | 7 | 7 | 7 | 6 ½ |
| Height of bolt extending above foundation .....H | 1 ½ | 2 | 2 ⅛ | 2 ¼ | 2 ½ | 2 ¾ |
| Depth of bolt in foundation .....I | 20 | 24 | 24 | 30 | 36 | 40 |

## PRACTICAL ILLUSTRATION OF FIG. 1.

In laying out the foundation of a 16 H.P. engine observe that A is 25, B 72, C 18½, D 60¾, H 2½, I 36, etc. Therefore the base of the engine is 25 inches wide by 72 inches long, the holes crossways 18½ inches, lengthwise 60¾ inches, distance bolts project above foundation 2½ inces, length of bolt in foundation 36 inches. Similarly you may find position of crank-shaft, pulley, etc. All the measurements are taken from the centre of the holes.

Fig. 2 and 3 represent the plans and elevations of the full base, and of the half base respectively of the 25 H.P. engine. Fig. 2 and 3 do not show the distance from bolt holes to centre of crank-shaft, nor the distance from inside face of driving pulley to front bolt hole. These distances are as follows:—On the full base, the distance from bolt holes to centre of crank-shaft is 14¾ inches; from front bolt hole to inside face of driving pulley on the exhaust side is 5¼ inches. On the half base the distance from front bolt holes to centre of crank-saft is 11 inches, and from front bolt hole to inside face of driving pulley is 8½ inches on the exhaust side.

## SETTING UP ENGINE.

After the engine is placed on the foundation and securely fastened down, proceed to replace all loose parts that have been removed for shipment. Remove all dust and cinders that may have lodged in the working parts during transit.

Piping or connecting up the engine consists of piping up the fuel, piping away the exhaust, and piping water to and from the engine.

## WATER PIPING.

All gas engines are provided with an outer casing or jacket, leaving an intervening space through which water is kept circulating. The object of the water is not to keep the cylinder cold, but simply cool enough to prevent the lubricating oil from burning. A lack of cooling water prevents the carrying off of the excessive heat, and causes undue expansion and friction of the piston, as well as interference with proper lubrication.

Our engines may be cooled by any one of tne following methods: Cooling tank, hydrant, or our patent water cooler.

## COOLING WATER TANK.

Figure 4 shows a circulating water cooling tank which is an economical plan for cooling engines of various sizes.

When the engine is working, the water in the cylinder jacket becomes heated and rises through upper pipes (No. 5) to the top of the tank, while the cooler water at the bottom of the tank flows into the cylinder through the lower pipe (No. 4).

In the Cut (Fig. 4) the cooling tank is elevated so that the inlet pipe (No. 4) is on a direct line with the inlet of the engine. Theoretically speaking this is correct, but for all practical purposes the **tank** may be placed on a level with the engine. It should be situated as close to the engine as conditions will allow, providing it does not interfere with or obstruct the attendant from operating the same. It may be placed in any position, on the level, or above the engine where it is most convenient.

## FULL BASE

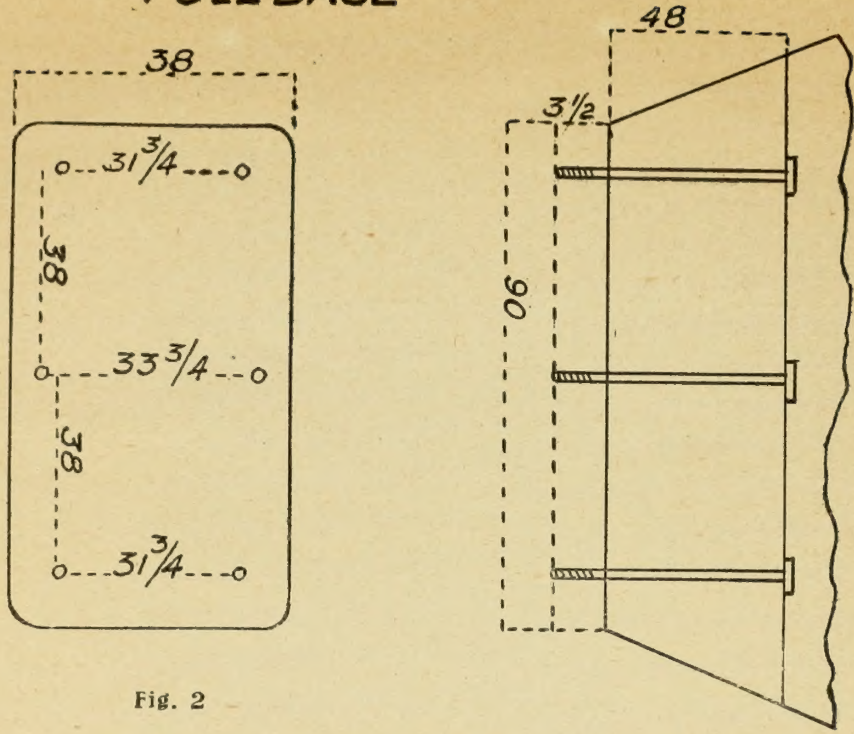



Fig. 2

## HALF BASE

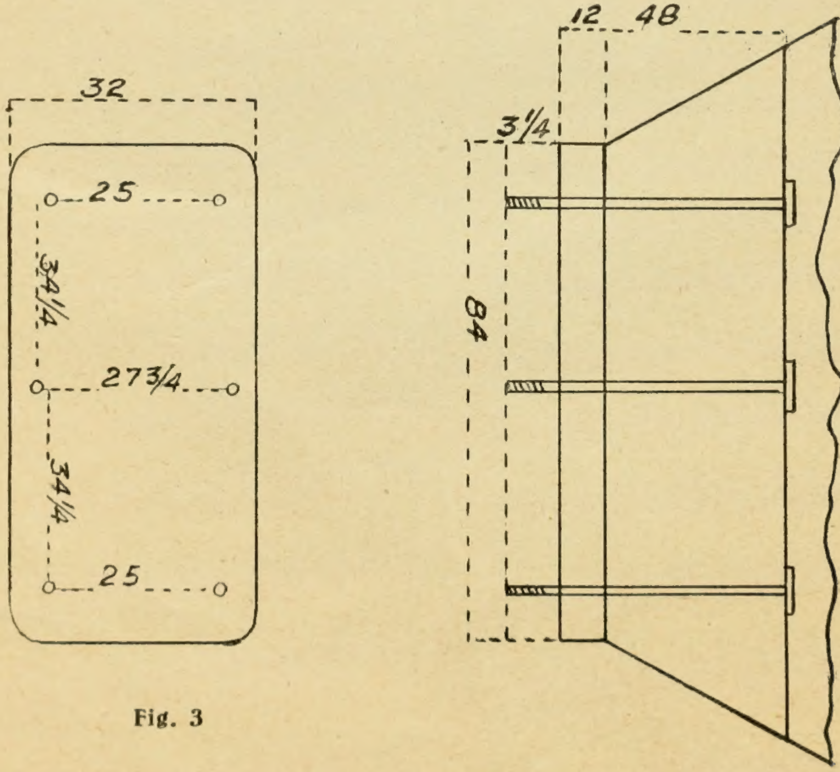



Fig. 3

A union should be placed on the lower pipe (No. 4) and upper pipe (No. 5) as close to the engine as possible. At the lowest point of the inlet pipe (No. 4) a drain cock should be attached (see No. 11). It is not necessary that this be attached close to the engine, providing it is placed at the lowest point in the pipe between the engine and tank. Stop-cocks should be placed on both the inlet pipe (No. 4) and upper pipe (No. 5) as close to the tank as possible. The Cut (Fig. 4) shows the stopcocks (No. 1 and No. 2) with handles attached to operate the same, inside the tank, which is most convenient in cold weather, as the pipes can be thoroughly drained as well as the engine jacket.

The upper pipe (No. 5) should slope slightly towards the engine and a vent pipe (No. 6) provided to allow free circulation and drainage of water. If it is necessary to place the tank at a considerable distance from the engine, we would advise placing the vent pipe closer to the tank.

When there is a vibration to the engine, or when tank cannot be placed so as to make any setting or moving of same improbable, we would suggest that short pieces of rubber hose be used to make connection on circulation pipes instead of unions.

The level of the water in the tank should always be kept above the upper pipe to insure proper circulation.

Water may be used from tanks situated below the level of the engine, or from underground cisterns, by the use of our circulating water-pump belted to the engine or shaft.

In making water connections with the tank, pipe of the size indicated by the ports in the water jacket should be used.

## COOLING BY HYDRANT.

Water from a hydrant, or from any other source where a continuous stream of cooling water is available, makes an excellent system for cooling an engine. In a system of this kind, however, the operator must be careful not to keep the cylinder too cool. If water from a hydrant is forced around the cylinder so rapidly as to keep it cold, the heat from the explosions in combustion is cooled down so quickly by radiation that the expansive force is materially reduced, and consequently there is less power.

When the hydrant system is used, connect the inlet pipe from the hydrant to the same point in the engine as in the tank system, with valve and draincock to guard against freezing.

The outlet pipe from the top of the cylinder should be piped away to a drain or waste trough in such a manner as to expose to view the stream of water leaving the engine. The water may be regulated by means of the globe valve or stopcock on the inlet pipe, so that the temperature of the water leaving the jacket through the outlet pipe is about 160 degrees, Fahrenheit. Always close globe valve when the engine is running, and, if it is stopped for any length of time, open the drain cock and drain the cylinder, as water might sweat in, or by condensation cause difficulty in starting the engine. This operation is absolutely necessary in frosty weather.

## PATENT WATER COOLER.

Our patent water cooler is used mostly on mounted or portable engines, but where water is scarce, and in an extremely cold locality, it can be adapted to stationary engines equally as well.

The cut (Fig. 5, page 8) is intended in a general way to show the manner of connecting our patent water cooler with the engine. Note specially that the air holes in the cooler are higher than the centrifugal pump on the engine. This is absolutely necessary to give the pump sufficient priming, otherwise the cooler does not need to occupy the position in relation to the engine as shown in the illustration, as it can be placed in front of the engine equally as well.

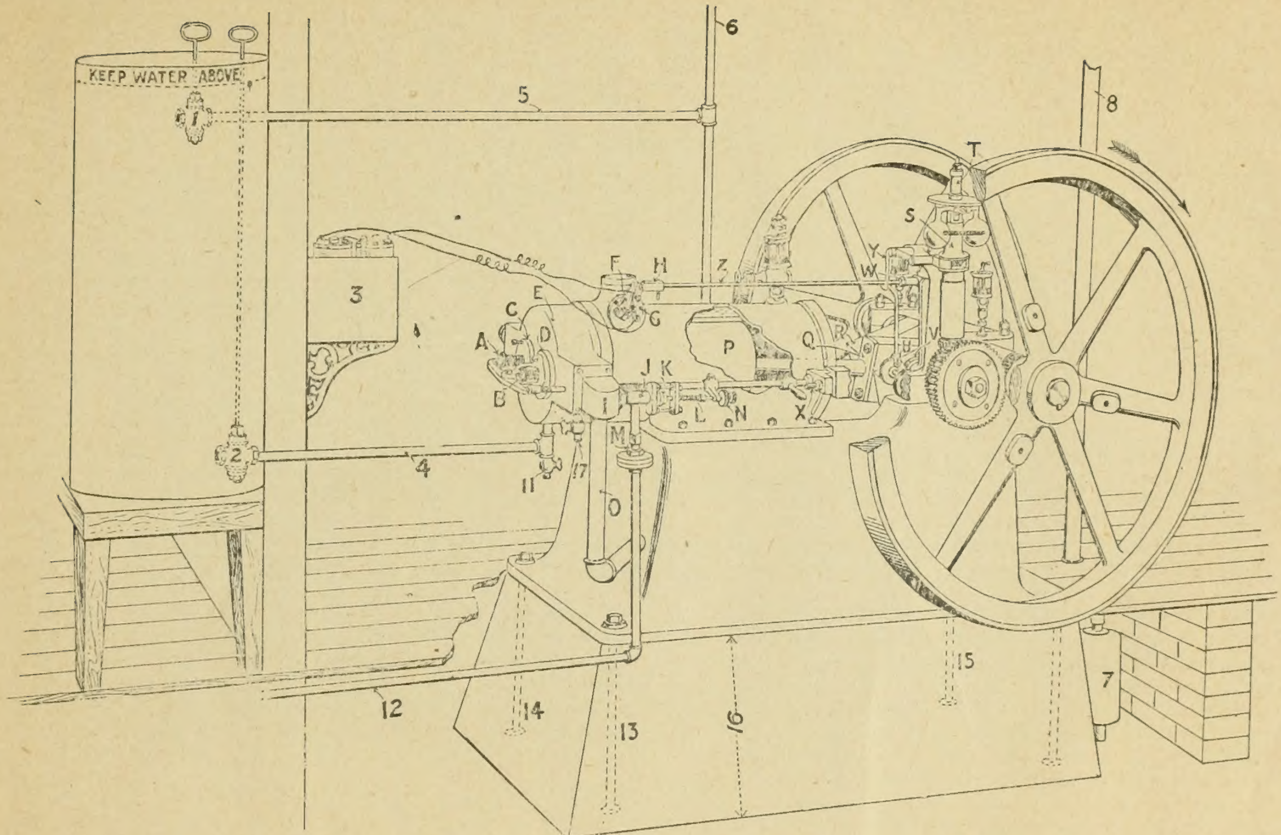



FIG. 4.

"IDEAL" GASOLINE ENGINE, SHOWING VARIOUS PARTS.

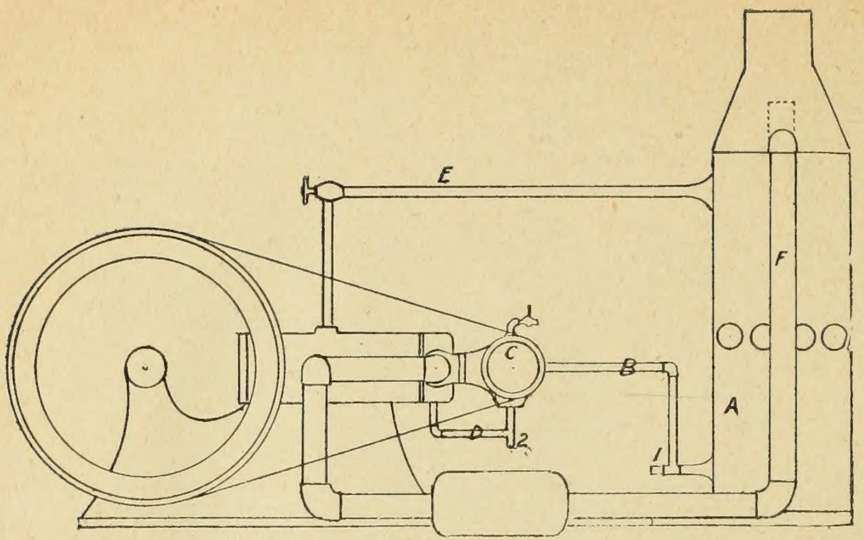



**FIG. 5. PATENT WATER COOLER.**

The cooler works on the following principle:—The water is drawn from the bottom portion or reservoir of the cooler A through the pipe B by the centrifugal pump C, which also through pipe D forces the water through the cylinder of the engine and back into the top of the cooler in a spray by way of pipe E, where it returns over discs to the reservoir at the bottom. At the same time the exhaust of the engine, which is carried to the top of the cooler through pipe F, is drawing cold air from the air holes G up through the cooler, and this cold air comes in contact with the heated water and keeps it at the desired temperature, preferably about 160 degrees.

The bottom portion of the cooler needs to be filled only when starting; after that, all the water that is required is enough to replace evaporation.

An angle valve is placed on the upper pipe E to regulate the quantity of water entering the cooler. A pet cock is placed on the centrifugal pump for testing the pressure of water, giving vent for drainage, etc., and the two drain plugs marked 1 and 2 **must always be removed in frosty weather** to drain water out of cooler, cylinder, pump, etc., as there is **more damage done from the neglect of this operation** than from all other sources.

When space must be economized, and on smaller sized engines we furnish a cooler with reservoir of smaller capacity which can be attached to the top of the cylinder, the principle of the piping being the same.

When we furnish a cooler with an engine not only do we make all pipe connections, etc., at the factory, but the engine and cooler are tested together. They are then shipped together unless otherwise ordered, or unless the saving of freight makes it necessary to ship them separately. In the latter case both should be readily set up, having been assembled and tested together.

The centrifugal pump can be attached to any of our engines simply by removing a flange on the exhaust pipe and replacing by one of special design to fit the pump.

## EXHAUST PIPING.

The two exhaust ports on our engines are connected at the factory, and all that is necessary is to continue the pipe to the outside of the building. But if the pipe which connects the two ports of the engine obstructs or interferes with the drive belt, this pipe may be placed in another position, but never under any circumstances decrease its size.

To avoid back pressure and consequent loss of power, the exhaust gases must be carried off quickly; therefore, long lengths of exhaust pipes should be avoided. But we do not believe in obstructing the engine room, or in placing the exit for the burnt gases in an objectionable or annoying position in order to have a short exhaust pipe; for all our engines (which are of the scavenging type) will develop the horse power under which they are rated with a reasonable length of exhaust pipe.

If conditions make it necessary to carry the exhaust pipe further than fifty feet, and especially if several turns are used, the size of the pipe should be increased.

The exhaust pipe may be carried up a flue or chimney to the outside air. In no case should the burnt gases be turned into any flue or chimney.

We furnish a muffler with our engines generally placed at the end of the exhaust pipe, but connectable with any other portion thereof.

Place the muffler so that the exhaust will not shoot upwards, but horizontally, or better still, in a downward direction. This will prevent the accumulation of rain, snow or ice in the mouth of the opening, and so will avoid interference with the free exhaust.

When the engine is so situated that the slightest noise of the exhaust is objectionable, there are various devices by which the exhaust can be made entirely noiseless, such as underground pits, etc.

A simple but effective muffling pit can be constructed in the following manner:—Take an ordinary barrel of about 45 gallons capacity, excavate a hole of about the same depth as the barrel, and at least a foot larger in diameter; place the barrel in the centre of the excavation with the open end down; fill in between the barrel and the earth with concrete, and when the concrete has set, knock out the end or top of the barrel and let the muffler or end of the exhaust pipe enter. A vent pipe a size or two larger than the exhaust pipe and made of galvanized iron or tin should be placed on the top of the barrel to carry off burnt gases, etc.

Since this pit has a ground floor any water or moisture from condensation is allowed to escape. The pit should be thoroughly covered with earth.

## GASOLINE PIPING.

When gasoline is used for fuel it is brought from a tank situated at some distance from the engine, and is forced or sprayed into the combustion chamber of the same by means of a small pump.

The gasoline tank may be located any distance you wish from the building or engine, but it should be so situated that the top of the tank is on the same level, or is the same height, as the gasoline pump (see Fig. 4, letter J).

The tank should be covered or enclosed to protect it from the sun, weather, etc., and it should be so placed that an attendant can have free access for filling and otherwise attending it.

Before making any connection, tap the pipes with a hammer, then remove all scale and dirt that may have been loosened. Do not use paints or leads in making joints, as they are dissolved by gasoline and rendered useless. Use common soap, or shellac, filling the threads on the end of the pipe with it before screwing together. Great care must be exercised in making the joints perfectly air-tight to insure proper action of the pump and also to guard against loss of gasoline. A stopcock should be placed at the gasoline tank, and pipe connected by a ground joint union. The gasoline pipe is connected with the engine by means of a brass union, the upper half of which is also a strainer (letter M, Fig. 4) for protecting the valves of the gasoline pump from dirt, scales, etc. The strainer we now furnish is slightly different from the one shown in the cut, but it works on the same principle.

On all our portable engines the gasoline tanks are situated in the base of the engine, and all pipe connections are made at the factory.

## GAS PIPING.

Because of the fact that gas does not enter the engine in a steady flow, but is drawn in at regular intervals with considerable speed by the suction, the size of the gas supply pipe must be large enough to prevent any resistence to the demands of the engine. The size of gas pipe must be decided by distance of engine from gas main, by number of turns or elbows in pipe, and by minimum gas pressure, and it must be of sufficient capacity to furnish the necessary pressure at the engine.

We furnish a gas bag or gasometer of ample size for usual pressure, and even if the pressure is low, providing the required supply of gas flows through the main, these will accumulate, give and supply, a sufficient quantity of gas for the engine to draw upon when necessary.

When manufactured gas is used for fuel, we usually supply a gas bag (see No. 14, Fig. 6, Page 11), which can also be adapted for natural gas if the pressure is regular. It should be placed in the most convenient position, as close to the engine as conditions will allow, and should be so situated that no oil will be thrown on the rubber diaphragm.

A union should be placed on the gas supply pipe between the gas bag (No. 14) and supply valve (No. 15) on the engine, and the stopcock attached to the inlet of the gas bag so that the pressure may be reduced if so desired.

We furnish a gasometer to regulate the pressure when the gas is irregular, as is generally the case when natural gas is used for heating, cooking, etc. Its parts are always connected or assembled at the factory, so if taken apart for shipment, they can readily be adjusted as before. The gasometer must be kept filled with water or oil to within a few inches of the top, to prevent escape of gas. It should be placed within at least 15 or 20 feet of the engine, and the gas pipe from the main or meter should be connected with the stopcock on the inlet pipe of the gasometer, the outlet pipe running to the supply valve on the engine. The gas should always be shut off at the meter when the engine is stopped for any length of time.

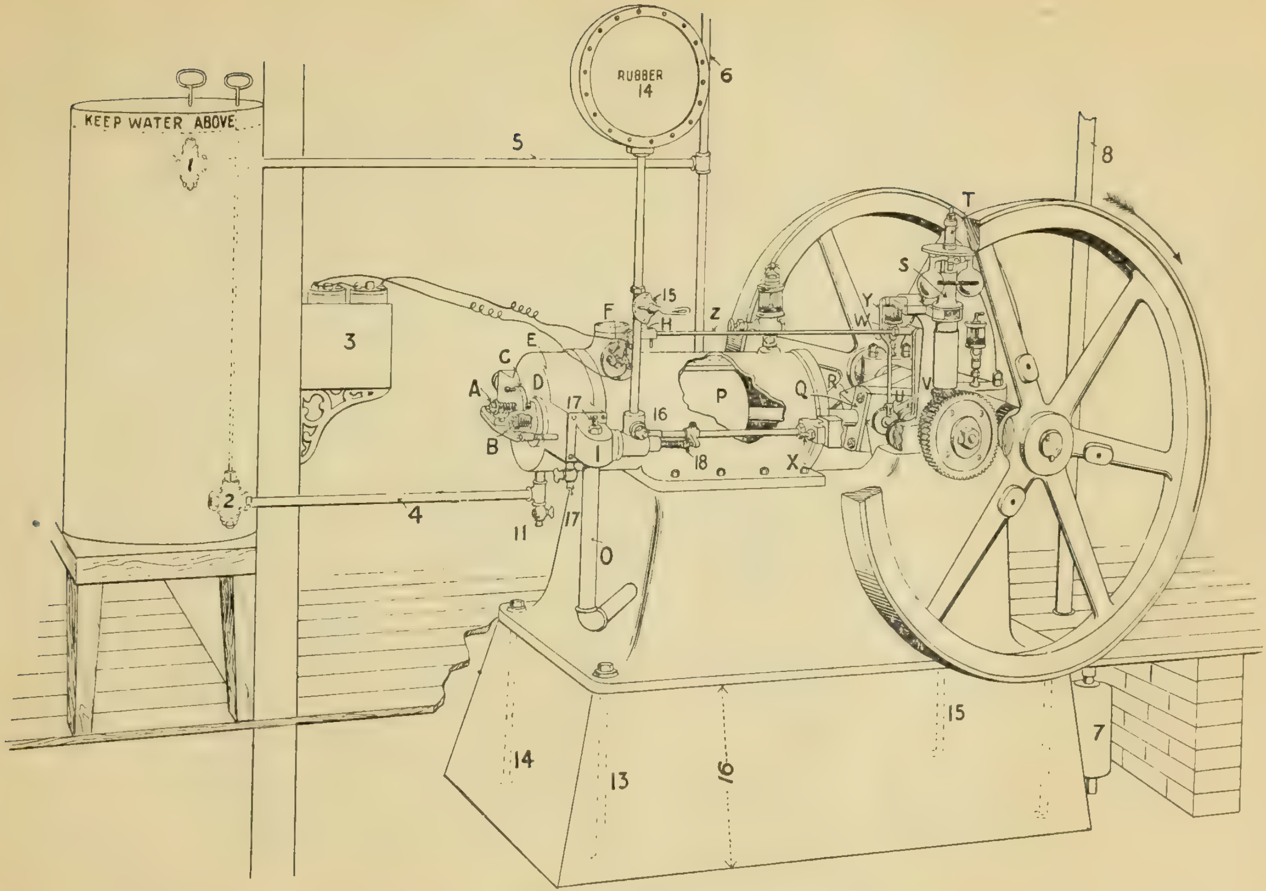



FIG. 6—"IDEAL" GAS ENGINE, SHOWING VARIOUS CONNECTIONS.

## IGNITION.

The power of a gas or gasoline engine is produced by the expansion caused by the explosion in the cylinder, behind the piston, of a charge of gas or gasoline properly mixed with air. The outward movement of the piston draws this charge into the cylinder, the inward movement compresses it, and when under the heaviest compression, it is exploded by an electric spark or by a hot tube.

## HOT TUBE.

We do not furnish a hot tube with our small-sized engines, but we supply them with larger sizes when specially ordered.

## ELECTRIC IGNITION.

We always give the electric method of ignition the preference in our engines, as it is cleaner and safer, as well as a surer method of ignition under a greater variety of conditions, since the spark is always made right in the cylinder in the gas mixture.

The electric spark is produced in our engines by quickly breaking a circuit in which the current is flowing through an inductive resistance or spark coil. Each side of the circuit is connected to points or electrodes on an igniter, part of which, together with the points, is in the combustion chamber. These points, one of which is insulated from the metal of the igniter, are brought together, then suddenly separated by the action of the igniter. This is called "the make and break" or "contact" spark.

The current of the electric spark is originated from a primary battery or dynamo, either or both of which we supply.

## BATTERY.

We furnish both liquid and dry cell batteries with our engines, including a spark coil, switch, and insulated wire for wiring the same.

## SPARK COIL.

The object of the spark coil is to build up, while the current is flowing, a strong magnetic field which represents stored magnetic energy, which helps to maintain the current when the sparking points are separated.

The coil which is manufactured by us consists of a core, composed of thin iron wires, which are tightly wound with nearly 6 lbs. of insulated copper wire. The soft wires in the core are properly proportioned to the insulated wire with which they are wound, and the coil on account of its short length magnetizes and discharges instantaneously. The coil is immersed in boiling paraffine wax to make the insulation perfect, and when connected with a battery, requires no further care, provided it is kept dry.

## DRY BATTERY. .

A dry cell battery of the usual type consists of a zinc cell, which forms the negative element of the battery.

The electroyle is generally a jelly-like compound containing sal ammonia, chloride of zinc, etc. The carbon, or positive element, is enclosed in a bag containing dioxide of magnese and crushed coke, which are the depolarizing agents of the battery.

Dry cells are connected in series with a spark coil in the same manner as the liquid batteries. As damp air is a good conductor and a destroyer of dry cells, it is a good plan to see that the box, in which these are enclosed, is well protected from dampness.

Unless you have an ammeter or battery tester, be careful in purchasing your cells. If dry cells are kept in stock for any length of time, deterioration takes place; they lose their amperage even if no current is taken from them. and one dead or poor cell in a set is detrimental to the efficiency of the others. We supply only the best make of dry batteries; every cell is thoroughly inspected and tested by an expert before it is allowed to leave the factory. When the battery is exhausted it cannot be re-charged, remove and replace by new cells.

A battery which is almost exhausted may be renewed for a time in the following manner:—Remove the pasteboard cover from around the zinc case and punch a number of holes in the zinc, about 3 to the square inch. Immerse each cell in a **separate** jar containing a solution of one part of sal ammoniac to five parts water; solution should come within an inch of the top of the dry cell.

## LIQUID OR WET BATTERY.

Each box of batteries and each set of renewals contains a copy of special instructions for charging and connecting cells. These directions must be carefully followed in every particular.

The charge in each cell is so regulated that when one part needs renewing, a complete renewal should be made, so that if the battery is properly charged, it needs no attention until completely exhausted.

Always place the battery and spark coil in a dry place (never against a stone, brick or cement wall) where it will be free from vibration or danger of breakage. A good plan is to place them either in a box or cupboard, so disposed that the battery cells may be readily uncovered for inspection and easily removed.

Connect the cells in series as shown in Fig. 7, page 15. Place the switch near the engine in some convenient position, and be certain that the ends of the wires are scraped clean at every connection, and that the screws and binding blocks are down tight on the wires.

**The spark may be tested** by placing the two wires together then "**snapping**" them apart to make a quick break. The igniting spark should be of a bright, white color. The switch must always be thrown out when the engine is stopped, otherwise the battery may remain in circuit and exhaust very rapidly.

## GENERAL REMARKS ON BATTERY.

A bright white spark indicates a good battery.

A red spark is a sign that the battery is becoming weak or exhausted. Examine each cell separately. If one cell shows signs of being further exhausted than the others, that is, if it is zinc consumed, etc., it should be cut out, and if all the cells are exhausted, the battery should be renewed.

In the Edison Lelande battery, as the copper oxide blocks are consumed, the oxide turns from black to red, and by cutting into the same with a sharp instrument, an approximate estimate may be made of the remaining life of the cell, by the proportion of the black oxide to the red.

When the character or appearance of the spark is of a scattering nature, that is, a series of small sparks in all directions, it is almost a certainty that the spark coil is short circuited.

If the battery gives no spark, examine all the wires, connections, etc., before you condemn it; a loose connection may cause all the trouble.

## DYNAMOS.

When ordered, we supply engines with either of two sparking dynamos, one of which is propelled by a small friction pulley in direct contact with the face of the fly-wheel, and the other is driven by belt from the fly-wheel or shaft. The former will, when connected with spark coil, start an engine without the use of batteries, providing that the engine is turned over in the direction it is to run, at the speed that is usually had in starting with batteries. The latter must be used in connection with a battery, as it will not generate an igniting current, until nearly the full speed of the engine is attained; consequently the engine is started from a battery, and when the dynamo has gained a generating current, it can be switched on the engine, and the battery cut out.

When used in conjunction with batteries, dynamos should be connected as shown in Fig. 7, Page 15.

When dynamos are sent out independent of engines, they are connected so as to run in the direction indicated by the arrow, which is placed upon them.

When portable engines are sent out with dynamos attached for sparking purposes, the dynamos are sometimes so placed that they run in the direction opposite to that indicated by the arrow. This change of direction is accomplished by reversing the two field wires which connect the field coil and armateur pole; this operation changes the polarity of the dynamo also, that is, the pole marked X is now the negative.

The dynamos require but little care, providing they are kept clean and dry. Dampness and dirt are their direct enemies. They are provided with compression grease cups and wick-oilers, etc., and need but little oil. When used too freely lubricating oil becomes dirt.

If the dynamo does not generate, when it is running near the speed which is indicated on it, and in the right direction for which it is connected, the trouble may be caused by the brushes making poor contact with the commutator. In this case, increase tension on the brushes by means of the springs, and if the commutator looks dirty, clean with a piece of clean rag, chamois skin, or number O. O. sand paper.

If the dynamo is driven by small friction wheel against the fly-wheel, see that the governor acts promptly, and that the speed does not exceed the number of revolutions marked on the dynamo.

If the dynamo is driven from the fly-wheel or shaft by belt, see that the driven pulley on the dynamo is tight and does not slip.

We can also supply magneto for sparking, when ordered.

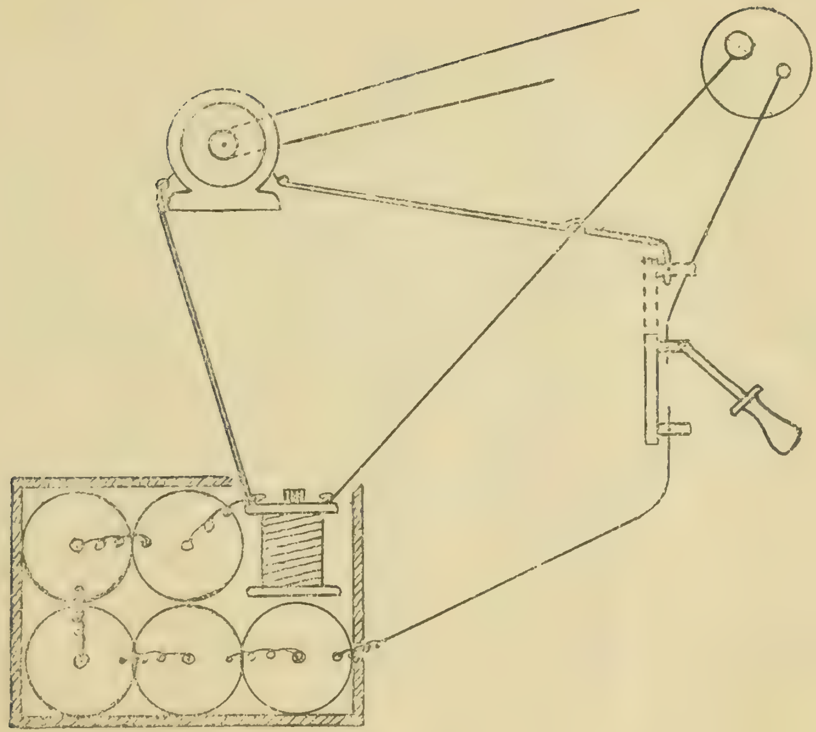


FIG. 7.

The current from a dynamo ignition is tested, while the dynamo is running at its rated speed, by attaching a piece of wire to one binding post of the machine, and snapping the other end off the other binding post, or better still, by placing the spark coil in the circuit, and you get the full benefit of the current, and can judge the igniting qualities of the spark by its size and color.

## THE UNDERLYING PRINCIPLES OF THE ENGINE.

It is not absolutely necessary that the purchaser or operator of our engine should understand all its details or intricacies in order to operate it successfull. This is far from being the case, since there are many owners of our engines today, who have no trouble whatever in operating them successfully, and yet know but little more than how to start and stop them.

Now, the aim of this book is to give a purchaser such an insight into the workings of our engine, that he may be able to fix anything that may go wrong with it, without the loss of considerable time spent in trying to find the cause of the trouble. What we want to impress upon your mind is this:—If you wish to get the best results from your engine, i.e., economy of fuel, power, etc., you must understand some at least of the principles of its construction.

If you take an interest in your engine, giving it some care and attention, you may be sure that it will repay you by giving long and faithful service.

Before starting the engine it would be wise to study the cycle which the engine completes in four acts, (and hence which is called the "Four Cycle Movement of the Engine"), as well as the three principles involved, viz., mixture, compression and ignition.

## THE FOUR CYCLE MOVEMENT.

The four-cycle movement is as follows:—The piston makes four single strokes, and the fly-wheels two revolutions to each opening of the fuel, inlet, and exhaust valves and each spark of the igniter.

Turn the engine till it is on the back centre of its free revolution, and we will take the four strokes or operations of the piston which in turn complete the cycle.

### 1. INLET OR CHARGING STROKE.

The piston being as far back as possible in the cylinder, turn the fly-wheel slowly forward, and the crank begins to pull the piston out, at the same time causing suction which opens the inlet valve, drawing in a charge of mixed gas and air, so that when the piston has reached the end of the stroke, the space behind it is completely filled.

### 2. COMPRESSION STROKE.

The piston has gone forward as far as possible; it now starts to go back in, compressing the mixture of gas and air, and as the piston reaches the end of its compression stroke, the charge is ignited by the electric spark.

3. EXPANSION OR WORKING STROKE.

Is caused by the ignition of the charge; the piston is forcibly pushed out by the explosion of the gas; this is the working stroke, the energy of which is transmitted to and stored by the fly-wheels.

4. EXHAUST STROKE.

Shortly after the piston starts to return, and before it has completely covered the exhaust port, when the major portion of burnt gases escapes, the exhaust valve starts to open and the returning piston drives the remaining gases before it and out through the exhaust valve; the cylinder is now swept clean, ready for another charge, and the "Cycle" is complete.

## MIXTURE.

The engine must be fed by a mixture of gas and air in equal proportions.

The adjustment of the air supply is important when the engine is operated by gas, and on all gasoline engines over 10 H. P. Gasoline engines under 10 H. P. are allowed to take air to the fullest capacity of the air pipe, the proper mixture being obtained by varying the quantity of gasoline; this is done by regulating the screw L Fig. 4, Page 7.

If the engine is operated by gas the quantity of both air and gas must be regulated. The quantity of air is regulated by the screw No. 17, Fig. 6, and the quantity of gas by screw No. 16, Fig. 6, Page 11.

Whether the engine is operated by gas or gasoline, the mixture must be regulated so that the engine will take the least possible number of charges of fuel per minute, and yet produce the required power and speed.

When gasoline engines over 10 H. P. cannot be given sufficient gasoline to make the proportion of air and gasoline equal, the air can be reduced by means of a valve similar to that shown on the gas engine, No. 17, Fig. 6.

The color of the exhaust will indicate quite clearly whether the proper proportions are being used. The color of the exhaust should be practically smokeless. A black, smoky exhaust indicates improper combustion, and results from too strong a mixture. A white, smoky exhaust indicates merely the use of too much lubricating oil.

## COMPRESSION.

In securing efficiency and economy, the compression of the charge is an important factor. Care should therefore always be taken to see that valves seat properly, and that cylinder rings, etc., are in proper condition.

The compression stroke of the engine is that following the inlet or charging stroke, and is very noticeable when turning the engine by hand; with the relief cock closed it will be found difficult to force the piston back on that stroke.

If, when turning the wheels by hand, they should be found to revolve easily through the entire cycle of two revolutions, that is, without the resistance that should be made by the compression, the cause should be immediately located, since it is impossible to start or operate the engine in such a condition. On a new engine, the trouble is generally caused by the air valve sticking or the exhaust valve seating improperly on account of the accumulation during transit of dust or sediment.

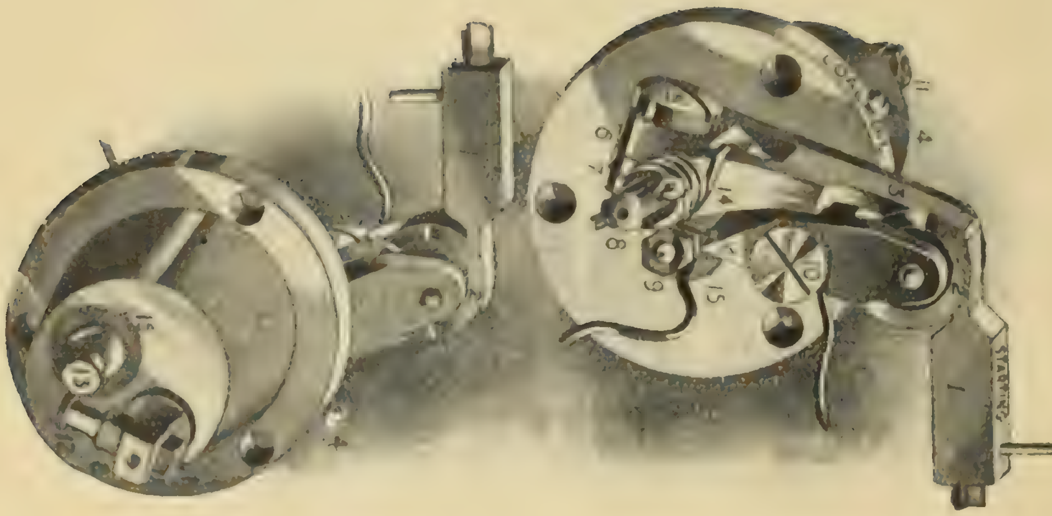


FIG. 8.—" IDEAL " IGNITER, SHOWING VARIOUS PARTS.

## IGNITER.

The arrangement by which the electric spark is made in our engines is called the igniter.

This consists of a cast-iron plug containing two electrodes or sparking points, one movable, the other stationary. Both of these electrodes are fitted with platinum rings at their point of contact. The igniter is fitted into the cylinder with the electrodes extending into the combustion chamber, and is held in its place—which is a ground joint seat and needs no packing—by three screws.

The arrangement and detail of the igniter may be studied from the cut of same (Fig. 8, page 18.)

The stationary electrode No. 13 consists of a large steel post which runs completely through the igniter and is held in position by means of a brass washer and nut. It is insulated from the metal of the igniter by means of mica washers, No. 15.

The movable electrode consists of a short steel post, No. 12, which is inserted in the rolling spindle, No. 8, and held in position by a brass nut. The rolling spindle which carries the movable electrode is fitted with a taper seat to that part of the igniter which extends into the combustion chamber, and passes on through the igniter fitted just loosely enough to prevent binding when expanded by heat.

When both the electrodes (Nos. 12 and 13) are in position they should have at least 1-32 inch separation. This is adjusted by loosening the clamping screw (No. 5) and turning the rolling spindle (No. 8) till the movable electrode (No. 12) is in the desired position.

## OPERATION OF IGNITER.

The igniter is operated as follows:—The two electrodes (Nos. 12 and 13) are brought together by means of the push block (No. 1) which forces the finger (No. 3) against the spring (No. 14) on the rolling spindle (No. 8) which carries the movable electrode (No. 12), thus causing the latter to approach the stationary electrode (No. 13), to gradually, but firmly press it, and to be separated instantly from it by the clock spring (No. 16) when the push block (No. 1) has reached that part of the stroke when it breaks connection with the finger (No. 3). As the spark is made when the two electrodes are separated—breaking the current—the push block can be adjusted in its stroke so as to change the time of the spark.

## TIMING IGNITER.

By timing the igniter is meant setting the igniter operating mechanism so that the spark will occur at the proper point during the stroke of the engine piston. This adjustment is made by simply lengthening or shortening the igniter rod which is attached to the push block, and is operated from an eccentric arm on the governor.

This rod should be so set that the push block—when placed with the side marked "starting" beneath—will break connection with the igniter when the piston and crank are in a position somewhat similar to that shown in cut, Fig. 9, Page 20.

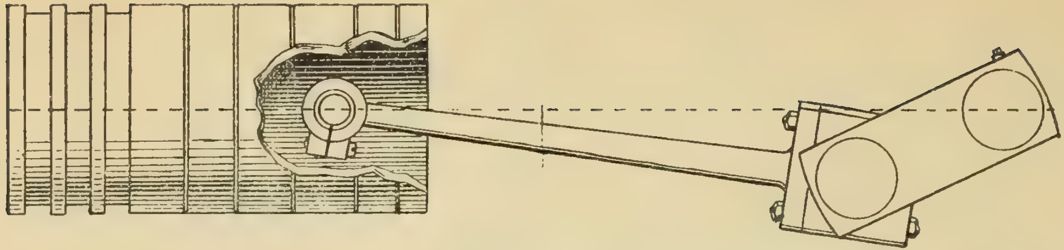


FIG. 9—PISTON AND CRANK CONNECTION, SHOWING POSITON OF CRANK AT TIME OF IGNITION.

There is no fixed point for the timing of igniter, however, as that depends on the speed and size of engine. For instance, while an engine running at a speed of 190 revolutions would, under average conditions, give its maximum efficiency igniting slightly below the centre, one running 400 revolutions might require ignition from 15 to 25 degrees below the centre.

Should ignition occur too late, it will cause the engine to be very extravagant on fuel, and to be deficient in power. If set too early—low on stroke—it not only reduces the power of engine but causes a heavy knock or pounding noise at each explosion. This is detrimental to the engine, and should not be allowed to continue.

Every engine is tested thoroughly at the factory and is shipped with the igniter timed so that the engine will give the most power.

The push block is so constructed that by placing the side marked "starting" on top, it retards the time of spark, causing the ignition to take place when the crank is above the centre, so that there is no danger when starting the engine of it "kicking back." The block must always be placed with the side marked "starting" down, when the engine has regained its speed.

## CARE OF IGNITER.

The principal attention that the igniter requires is to see that every nut and screw is tight, to turn the electrodes or platinum points occasionally, and to see that the igniter is properly timed.

To determine whether a spark is actually passing between the electrodes, detach the wire from the binding post (No. 10), then hold the two electrodes together by pressing back the finger (No. 3); then brush the loose wire across any finished metal of the engine. If there is no spark it may be due to the forming of carbon or rust on the electrodes. If so remove the igniter from its seat, clean the electrodes with emery cloth or waste; test the movable electrode by snapping finger (No. 3) by hand; if it does not act freely (i. e., if it does not come in contact with the stationary electrode and separate instantly from it, when the finger is "snapped"), it may be that the spindle (No. 8) which carries the movable electrode, is binding in its journal; if so, loosen it by putting a few drops of coal oil in the oil hole (No. 4), if this fails to loosen it, take out the spindle, clean it thoroughly.

After replacing the igniter parts and before putting back the igniter, fasten the loosened wire to the binding post (No. 10) and snap the finger (No. 3) by hand, and see that a spark passes between the electrodes. The two electrodes should have about 1-32 inch separation as previously described, but the distance may be increased by the platinum burning away. This can be remedied by turning the electrodes to a fresh point of contact. Nut No. 11 is loosened to change the movable, and nut No. 5 to change the stationary electrode. If the wires are not changed, but each wire left connected to the electrode to which it was originally connected, you will notice that only one of the electrodes will burn. By turning this electrode till one small point is left, and by changing the wire from one post to the other, you will cause the other platinum washer to burn, and you will obtain the full life of both electrodes.

If the two electrodes are separated and you can produce a spark by snapping the loose wire on any part of the igniter other than that of the binding post of the stationary electrode and its parts, there must be a short circuit caused by defective insulation. Examine the mica insulation (No. 15); if dirty from carbon, oil, etc., clean it thoroughly; if broken, remove and replace by new.

After having tested the igniter in the manner described, replace it and be sure to tighten the screws well, so as to avoid the possibility of a leakage of compression.

After replacing the igniter, it is always necessary to test the point of ignition.

You may test the distance between the electrodes without removing the igniter from its seat, by placing thumb and forefinger on the cotter pin (No. 7) and turning the igniter finger (No. 3) back until the electrodes meet. If the end of igniter finger moves more than 3-16 inch, the igniter should be removed, and the electrodes adjusted.

## STARTING ENGINE.

See that the electric wires are connected to their proper binding posts on the igniter. Oil the engine thoroughly, putting oil on all the working surfaces (the igniter Fig. 8 and the two valves C and D, Figs 4 and 6 should be oiled with coal oil only), see that the oil cups contain oil and that their feeds are properly adjusted; if grease cups are used, see that they are full, and screw them down a turn or two to make sure that they are working.

Open the relief cock on the side of the cylinder. Adjust the push block H, Fig. 4 and 6, so that the word "starting" is on top.

Pump up the gasoline till it comes out of pet cock (No. 17, Fig. 4) working the pump (J, Fig. 4) by hand. If using gas, open the gas supply cock (No. 15, Fig. 4); usually about one-quarter or one-third open is sufficient for starting.

Turn on the electric switch. Then turn the fly-wheel by hand quickly in the direction in which the engine is to run, and if you have followed the instructions, the engine will generally start on the second revolution.

After the engine has made a few revolutions you may close the relief cock, adjust the starting block (H, Fig. 4 and 6) so that the word "starting" is underneath, and turn on the water.

All our gas and gasoline engines up to about 10 H.P. may be started readily in the above manner, but on account of the difficulty of turning the fly-wheel over against the compression, in the larger sized engines we adopt a different mode of procedure in starting. This method is as follows:—

Relieve the compression. To do this place a small wedge about ⅛" in thickness between the end of the side rod and the lever that operates the exhaust valve stem near B, Fig. 4 and 6.

Turn the engine until the igniter has broken connection or snapped off, which will be in the back centre of the ignition stroke.

Remove the compression wedge; open the relief cock; adjust the push block for starting; turn on the electric switch.

Pump up the gasoline, or gas if used, open the gas supply valve, No. 15, Fig. 6, about one-third, then hold the gas valve, No. 18, Fig. 6, open for a moment to allow the gas to enter.

Turn the fly-wheel smartly one-half revolution ahead. Reverse the fly-wheel with a quick, snappy turn and as it comes back **almost** to its stopping point against the compression, snap the igniter. If these directions have been carefully followed the engine will start.

Try snapping the igniter two or three times before you start to turn the engine. If the engine does not start the first time, compress the engine, charge again by turning the engine back on itself and again snap the igniter.

You have a charge in the cylinder, and if the engine does not start it is because you have failed to explode the charge, either by not handling the igniter right, or by not turning the engine back sharply enough to give good compression. If you fail after two or three attempts, relieve the compression, turn the engine over a turn or two (if a gas engine see that the gas supply valve is closed) to clean out the remainder of the charge, and start again.

## STOPPING THE ENGINE.

1. Turn off gas.
2. Throw off switch.
3. Turn off oil cups.
4. Turn off water supply and drain cylinder.

N.B.—In cold weather the last operation may be done before the engine has been stopped, so that the operator is certain that the engine cylinder is completely drained.

## SUGGESTIONS ON STARTING A GAS ENGINE.

All gas engines are tested in the factory before shipment, under a certain gas pressure, and the valves which admit the gas are all adjusted to suit this pressure. Each engine is shipped with the valves so adjusted; the purchaser sets the engine up and connects it to a gas line, and the pressure now being different the valves must be adjusted.

A high pressure is always detrimental to easy starting. Do not blame the engine for refusing to start easily when the operator is the one at fault. On small engines from 3 to 8 H.P. keep the gas pressure on the gas bag as low as possible. All that is required is sufficient pressure to raise the diaphragm say about ¼ of an ounce on small engines, and from ½ to 1 ounce on larger engines.

It is our usual method to start the engines by only slightly opening the gas supply valve, No. 15, Fig 6, then regulating the gas down at the gas bag by means of stop-cock, after opening the gas supply valve fully, until the diaphragm drops flat, and does not respond between charges; then open stop-cock until the diaphragm fills easily between charges, at which point it should be allowed to remain.

When a gasometer is used instead of a gas bag, the gas pressure requires no adjusting.

Before starting a new engine it is advisable to remove the gas regulating screw, No. 16, Fig. 6, then open the supply valve, No. 15, Fig. 6, and hold the gas valve, No. 18, Fig. 6, open a moment or two to clear out the air which may have accumulated in the pipes. During this operation it is wise to open doors or windows to prevent any explosion which might occur from escaping gas.) Replace gas regulating screw in the same position as before, and proceed to start the engine.

In starting a gas engine never open the gas supply valve when the engine is standing on the charging stroke. It is good practice to open the valve at the end of the compression stroke, or after the igniter has snapped off.

Often in starting an engine an inexperienced operator will flood the base of the engine with gas, making it a very difficult operation to start the engine, and in some cases an impossibility. He does this by opening the gas supply valve when the engine is standing on the charging stroke, allowing the gas to enter through the gas valve, No. 18, Fig 6, (which is held open by a can on the governor), and go down through the air pipe, No. 0, into the base of the engine. The base being filled with gas, it is therefore impossible for the engine to get a sufficient supply of air. To remedy this, close the gas supply valve and turn the engine over a few times to cleanse the base and allow fresh air to enter, or unscrew bottom portions of air pipe and take fresh air from outside of engine base.

## SUGGESTIONS ON STARTING A GASOLINE ENGINE.

Note distinctly that the gasoline tank must be so placed that the top is not lower than the gasoline pump on the engine, as this pump cannot be expected to lift the gasoline higher than 2 feet.

If you have any difficulty in raising the gasoline, loosen the screw that sets the side arm that carries the gasoline adjusting screw N., Fig. 4, and slip this arm out of the way. Remove the nuts which hold the crossbar on the gasoline pump, J., Fig. 4, and give the plunger a longer stroke, working it by hand till the gasoline comes out of pet cock No. 17, Fig. 4. When the gasoline has been pumped up, replace the nuts and adjust the side arm as before.

When the temperature drops to freezing point, gasoline will not vaporize so readily, that is, the air will not take it up and hold it in suspension as a vapor. As our engine is so constructed that the air is made to pass directly through the gasoline after it is broken up in a spray we have little or no trouble with our engines in this respect.

In starting an engine in cold weather this simple but very effective mode of procedure may be followed: Take any long, slender instrument such as a screwdriver, a piece of wire, or a nail, and hold the inlet valve open by pressing it through an opening in hood D, Fig. 4, by means of this instrument; at the same time work the gasoline pump till you have forced a charge or two of gasoline into the cylinder or combustion chamber. Then start engine in the usual manner by means of switch, etc.

# Some Reasons for Difficulty in Starting an Engine

## 1. A VALVE STICKING.

Remove the hood which covers the valve B, Fig. 6 and 4, and work the valve by hand; give it a dose of coal oil.

## 2. POOR COMPRESSION.

The exhaust valve may be sticking; turn the engine around by hand and see that the valve seats properly; see that there is at least 1-32" play between the end of the valve and the lever which operates the same; see that the rod which operates the lever works freely. Test the engine for compression. If the valves leak they should be reground. If there is a leakage of compression through the cylinder, the rings may be gummed up and sticking in their grooves. The piston should be removed and the rings thoroughly cleaned with coal oil.

## 3. POOR IGNITION.

The switch may not be in; test the battery and spark. Insulation on stationary electrode may be broken; movable electrode may be loose; the spindle that carries the movable electrode may be sticking; the electrodes may be too close or too far apart. Read paragraphs under "Care of Igniter," Page 20.

## 4. WATER IN THE CYLINDER.

This may be easily detected by opening the relief cock and turning the engine round by hand. If no moisture is observed there, take out the igniter and examine the electrodes. If these are wet and rusted, dry and clean them. Sometimes the water will sweat on the cylinder if the engine has been standing some time with the water turned on. If water is observed on the piston, in the cylinder, or at the relief cock, is probably comes from defective packing; the cylinder head should be removed and repacked.

## 5. WATER IN THE GASOLINE.

The presence of water in the gasoline may be discovered by spattering a little gasoline with the finger on a flat piece of iron. If water is present it will show itself in small globules which will separate from the gasoline; otherwise the gasoline will spread itself out smoothly all over the iron. Another method of detecting the presence of water in the gasoline is by pouring some into a bottle. If water is present, it will separate from the gasoline and collect in the bottom portion of the bottle, while the gasoline may be seen on top.

## 6. POOR MIXTURE.

If in a gas engine, the gas may be shut off at the meter. The base may be flooded with gas. Close the gas supply valve and turn the engine over a few revolutions to work the surplus gas out through the exhaust valve.

If a gasoline engine, it may be getting either too little or too much gasoline. Adjust the screw N, Fig. 4, so that the engine will take gasoline either in greater or smaller quantities. Read paragraph under "Mixture," Page 17.

# General Information on the Engine

A coughing or barking sound when the engine is running indicates the escape of the explosive force past the piston rings. It is due usually to a dry piston, allowing the force of combustion to pass the rings. It can often be overcome by adjusting the lubricator for a freer oil supply without stopping the engine.

When a cylinder has run dry the piston should be taken out at the first opportunity and the rings and their seats thoroughly cleaned from burnt lubricating oil and deposits of carbon in the form of soot.

On the other hand, in adjusting the cylinder oil-cups for a freer supply of oil, do not flood the cylinder and piston with oil, as this causes smoke from the exhaust and carbon from the burning oil to be deposited on the piston and inside of cylinder as well as on the valve stems, etc.

We advise you to use nothing but a high fire test mineral oil for lubricating piston and cylinder; but where this cannot be obtained and an ordinary machine oil is used, it is well to clean the engine with coal oil regularly, say twice a month.

## EXPLOSIONS IN THE EXHAUST PIPE OR MUFFLER.

These are caused by the accumulation of unexploded vapor from the engine, generally the result of ignition missing in the cylinder; the explosive mixture then passing out into the exhaust pipe or muffler is ignited by the next exhaust causing a loud explosion.

This missing ignition is generally due to a defective spark or wrong mixture. (See Care of Igniter, Mixture, Etc.), although it may also be caused by exhaust valve sticking or seating improperly.

## BACK FIRING.

This terms is used to describe explosions in the air-pipe and base of engine. This is generally caused by a delay of combustion of the previous charge. A mixture with not enough gas or gasoline in proportion to the air burns slowly, so much so that it continues to burn not only on the working stroke but also on the exhaust stroke of piston, leaving enough flame in the cylinder to fire the fresh incoming charge, which, of course, escapes back through the air-pipe, the fuel valve being open. To remedy this, give the engine more fuel, or close off the air supply a little.

These explosions are also produced when anything interferes with the proper seating of the fuel or air valve.

## MISSING EXPLOSIONS.

No engine is working efficiently unless every charge entering the cylinder is exploded. If charges are passed through the cylinder without ignition, it not only reduces the power of the engine, but also wastes fuel and causes irregularity of speed. To make sure that every charge is ignited, open the relief cock on the side of the cylinder, and be certain that an explosion follows every opening of the gas valve, or stroke of the gasoline pump.

These missing explosions are generally caused by defective ignition or insufficient fuel. Examine igniter, battery, etc.

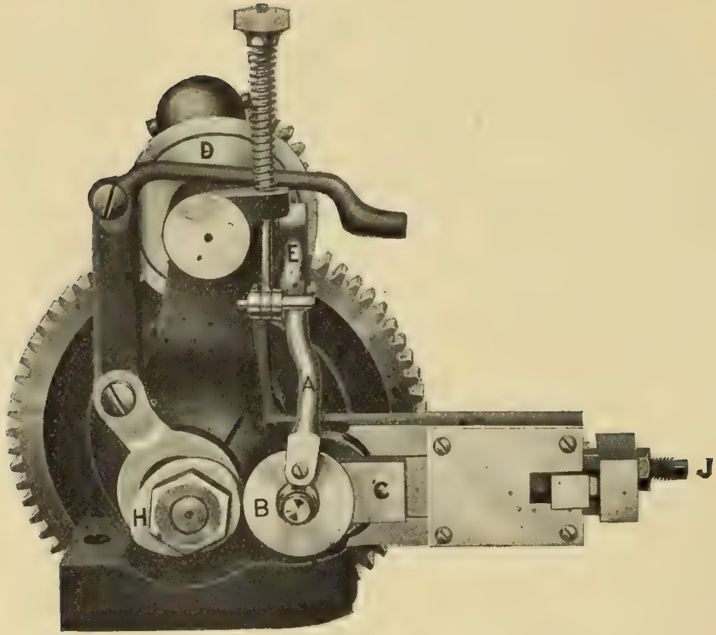



FIG. 10.

## GOVERNOR.

The arrangement and detail of the governor may be studied from cut of same, Fig. 10, Page 26.

The governor regulates the speed by acting on the roller B through the lever A. With the increase of speed the governor balls fly out, causing the spool D to push against the roller E on the upper end of the governor lever. This causes the lower end of the lever to move inward, taking roller B out of its regular position on the pin attached to the governor slide C, (which operates the gas valve or gasoline pump), so that the fuel cam H on the main shaft will not strike it. This operation is called " cutting out," that is, when the roller B is moved out of its position in relation to the fuel cam H, there is no movement of the governor slide which operates the valve or pump; consequently no charge is taken.

When one side of the fuel cam H is worn, the cam may be reversed, thus causing it to last twice as long.

## SETTING GOVERNOR.

The valves, igniter, etc., are all operated by the action of the governor, and as they all perform certain operations at certain times, it is necessary when placing a governor on an engine to set it as to cause these operations to be performed in the right rotation. While this operation is very important, it is quite simple, as all that is necessary is to place the governor so that when the engine is turned in the right direction it is to run, the exhaust valve will start to open, when the engine crank is slightly below the front centre, and close when the crank reaches the back centre. The governor is so constructed that when the exhaust valve is timed or adjusted properly, the fuel valve, igniter, etc., follow in their right rotation.

Place the governor in the following manner:—Turn the engine till it is on its back centre, (when in this position the piston is at the farthest extremity of its stroke in the cylinder). Place and adjust the governor so that when the engine is turned backwards, (or in the direction opposite to that in which it is to run), the governor slide K immediately starts to open. To test this operation turn the engine in the same direction till you have reached the front centre; shove the slide K by hand back to its original position; turn engine in the opposite direction to that which it has been turned, but in the direction in which it is to run, and the slide K should start to open when the crank is slightly below the centre.

When the fuel cam H and the fuel roller B are in the position shown in the cut, Fig. 10, they should have at least 1-32" separation. This distance can be adjusted by means of the screw J.

This is a very important point to remember for if cam and rollers are allowed to come too close together, the momentum of the balls would not be sufficient, by means of spool, lever, etc., to push the roller out of its position in relation to the cam, until the engine had exceeded its usual speed. Moreover, under these conditions, when the roller is once off the cam, it does not easily regain its regular position; this retards the speed of the engine.

The governor will also work irregularly if the working parts are allowed to " gum up " from dirt or the use of too heavy lubricating oil. They should be cleanel occasionally with coal oil or gasoline.

The exhaust cam, igniter roller, and gasoline cam are all placed on the main shaft of the governor with a pin extending through them all, and they are held in position by means of a **nut with left hand thread.**

If the cams or roller are removed at any time care should be exercised in replacing them in the same position as before.

The cams are so placed on the shaft that when the engine is turned in the direction in which it is to run, the exhaust cam always leads the gasoline cam.

The gasoline cam contains two pin holes. If at any time this cam is removed it should be replaced on the shaft with the pin extending through the hole nearest the front of the engine.

## GASOLINE PUMP.

If at any time you have any trouble in pumping up the gasoline, if the pump loses its priming, or if sufficient gasoline cannot be supplied to meet the demands of the engine, look for the trouble in the suction valve of the pump.

This valve may be sticking, or dirt or sediment may cause it to seat improperly.

To remove the valve, disconnect the gasoline pipe at the union and unscrew the top portion of the union, which contains the valve and its seat, from the pump.

If you wish to examine the pump and all its parts, disconnect the gasoline pipe, unscrew the air pipe O, Fig. 4, and remove the four screws which hold the air chamber I, Fig. 4 and 6, in position, and to which the pump it attached. Unscrew the brass jet tube from that portion of the pump which projects into the air chamber, then the pump may be easily removed.

The discharge valve is held to its seat by means of a small brass spring which can be easily examined by unscrewing the brass nut which holds the spring in position.

This pump will give long and efficient service with very little attention, as all its parts are made of the very best material procurable.

The packing around the plunger consists of vulcanized asbestos washers, which can be easily removed and renewed when worn or defective. A substitute for this packing is common candle wick but we do not recommend it as the gland nut must be screwed tighter to make it as efficient, causing unnecessary wear and friction on the plunger.

All the care or attention that the pump requires is to see that the gland nut on the pump is tight enough to prevent any leakage of gasoline and also to prevent air from entering. Oil the plunger occasionally. N. B. When the engine is standing for any length of time, say a month or so, remove the plunger, or thoroughly cover it with oil to prevent it from rusting, etc.

## FUEL OR AIR AND EXHAUST VALVES.

Never use ordinary lubricating oil on the fuel or exhaust valves. The heat simply burns it and leaves a gummy deposit on the stems which interferes with the free movement of the valves. They should be examined frequently and oiled occasionally with coal oil to keep them clean.

The two nuts on each valve which hold the spring in position should always be tightly locked together, especially those on the fuel valve for, as this valve opens by suction, there is a greater tendency for these nuts to become loosened and interfere with the proper seating of the valve. (See paragraph under "Back Firing." Page 25.)

No definite estimate can be given of the length of time valves should go before being reground, this depending to a certain extent on the load carried, grade of fuel, and other local conditions.

Under an average working load when a good quality of fuel is used, the valves on our engines will work for years without being reground.

When it is necessary to grind in either the fuel or exhaust valve, we would advise removing the cylinder head and grinding the valves to a true bearing without removing the valve chests from the cylinder head. As the former must be fitted snugly to the latter to withstand the compression, etc., it requires some considerable skill to draw them from their position, by means of the set screws, without danger of breaking them. Moreover, if the valve chests are removed or disturbed in their position, there is also a possibility of their leaking as well as the valves.

To grind in the valve, remove the nuts and spring from the end of valve stem, then remove valve from its seat on the chest. Oil the seat on the chest all around and, dropping some fine emery on it, replace the valve and revolve it in its seat, occasionally renewing the oil and emery until a perfect seat is ground both on the chest and valve palate.

The cylinder head of our largest engine can be removed and repacked in less than an hour, so it is by no means a tedious or difficult operation to regrind the valves by removing the cylinder head.

## REMOVING AND PACKING CYLINDER HEAD.

To remove the cylinder head, disconnect the screws which hold the exhaust piping and air chamber in position. (In a gasoline engine the air chamber **and pump** must be removed as the jet tube from the pump extends into the cylinder head.) Remove the rocker lever and the push rod which operates the same. Disconnect the lower water circulation pipe at the union, (the water being closed off at the tank, drained from cylinder, etc.,), then unscrew the nuts which hold the cylinder head and the same may be removed from its seat by lightly tapping it with a hammer.

The cylinder head is packed with sheet asbestos. After taking off the old packing be sure to clean thoroughly the surface covered by it, but do not injure the packing faces.

Use, for the new packing, asbestos of medium thickness, such as is furnished with the engine. If only thin sheet asbestos can be procured, use two thicknesses. Do not use asbestos board or rubber. When cutting a new gasket, say for the cylinder head, place the sheet of asbestos over packing face and mark holes, for studs and water circulation, with a small hammer, tapping lightly the places where you wish to cut the asbestcs.

Soak the gasket in boiled linseed oil, or, if this cannot be obtained, in heavy lubricating oil, and place on cylinder with no tears or breaks in same.

When the cylinder head has been replaced, draw the nuts down, tightening one slightly and then the one opposite it, and so on until all are tight. When the engine begins to get hot, tighten all the nuts again to take up **expansion.**

# Some General Points

Don't use cheap cylinder oil or steam engine oil on your engine. Use gas engine oil only.

Don't fail to oil your engine every time you run it and clean it up when through running.

Don't fail to see that the water is flowing or circulating properly when the engine is running.

Don't allow water to remain in the water jacket around the cylinder when the engine is idle on a cold day.

Don't (if you have the valves or igniter removed from the cylinder) look into the opening with a lighted match or lamp without first making sure that it does not contain a charge.

Don't forget to throw off the switch or disconnect the wire when through running.

Don't allow your gasoline pump to leak around the stuffing box or the gasoline pipe to leak at joints.

Don't keep your batteries or spark coil in a damp place.

Don't fail to examine your engine occasionally.

Don't look for gasoline leaks with a lighted lamp.

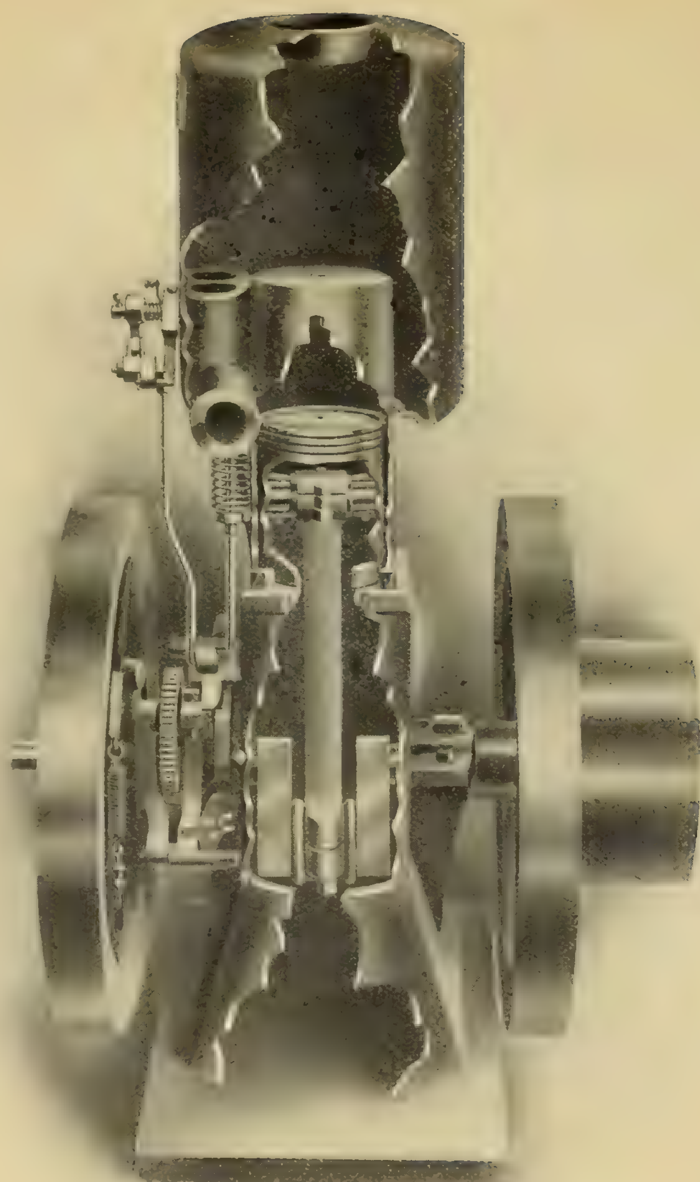
Don't be afraid of the engine. You cannot blow it up. If you give it too much gas or gasoline, you will simply shut down the engine by drowning the charges of air or by overcharging it out of proper proportion, thus making it non-explosive.

If you have any difficulty in starting or operating the engine, the trouble probably lies in either ignition, compression of charge or mixture of the fuel.

When in trouble, remove the igniter and try the spark.

Try the compression by turning the fly-wheels and see that the engine is getting fuel regularly and in the proper amount.

If there is anything about your engine which you do not understand, don't hesitate to write us.



1 1-2 and 2 1-2 H. P. Upright Engines

# 1 1-2 and 2 1-2 H. P. Upright Engines

Engines mounted on skids should be placed on cross timbers so that they will be level and have as little shake as possible. On engines intended for stationary work a concrete foundation is the best, but when this cannot be done, heavy pieces of timber should first be bolted to the floor. Engines that have a good solid foundation will give better service, as a poor foundation will have a tendency to loosen bolts, adjustments, etc.

In starting engines—

1st. Fill gasoline tank in the base by removing plug. It is well to strain the gasoline by placing a chamois over the funnel and allowing the gasoline to run through the chamois. This prevents water and dirt from getting in and causing trouble.

2nd. Connect the two wires from the battery box, one to the stationary annode and the other to the small screw on top of the igniter casting. The other small screw on the casting is for oiling the moving annode, and coal oil only should be used. A few drops once or twice a week is sufficient. See that all battery connections are tight.

Engines supplied with magnetos are shipped ready connected. See that no grease or oil gets on the edge of fly wheel to cause friction pulley to slip.

3rd. Pump up gasoline into the carburetor by using gasoline pump on side of engine base.

If the gasoline does not pump freely, put a few drops of oil on down feed pipe, by putting oil can in hole on top of carburetor; feed pipe hole can be seen inside of carburetor; pump until the carburetor is full, the overflow returns to tank down the overflow pipe.

4th. Fill the water hopper about three-quarters full, and take care not to splash water over the engine into carburetor.

5th. Fill oil cup on side of engine with gas engine oil and adjust it to feed from 5 to 6 drops per minute, also remove hand hole plate on side of crank case, and pour in enough oil to cover nut on bottom of connecting rod. This is sufficient to run the engine for four or five weeks. Do not put too much oil in crank case, as it will only splash out.

Use **only gas engine grade of oil.** Heavy oil burns and clogs engine, which will stop parts from working freely.

6th. Close the battery switch.

7th. When ready to start, place the starting crank on shaft on same side as igniter, and placing your thumb **half** across the air hole, turn the crank quickly, holding your thumb there until engine has taken two or three explosions.

If these directions are carefully followed the engine will start on the second or third revolution.

The speed of the engine may be regulated by small thumb screw on the side of governor. By screwing it in the engine will run slower, and screwing it out will increase the speed.

2½ H. P. engines are intended to run at 400 R. P. M.

1½ H. P. engines at 500 R. P. M.

8th. To stop engine, open switch, turn off adjusting screw on carburetor and oil cup. In cold weather drain the water out of hopper to prevent it freezing.

If for any reason, engine fails to start, first look at your battery connections, and see if they are tight and give a good spark. Don't forget to open switch when stopping, as battery will rapidly wear itself out, and be useless. A weak battery may start an engine, but will cause it to stop in a short time.

See that the igniter blocks trip at the right time, which should be when the crank is in position as indicated in cut.

Do not remove igniter from cylinder any oftener than is necessary, as you may break the asbestos packing and cause a leak in the compression.

Keep the engine well oiled, especially about the governor parts, using gas engine oi lon these parts.

Read directions for the magneto carefully. A set of directions is attached to each magneto.

Keep battery dry. Do not set on a damp floor.

GOOLD, SHAPLEY & MUIR CO., LIMITED.

# INDEX

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